THIS OPINION WAS NOT WRITTEN FOR PUBLICATION

The opinion in support of the decision being entered today (1) was not written for publication in a law journal and (2) is not binding precedent of the Board.

Paper No. 28

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte JOSEPH W. CARLSON,
LAWRENCE E. CROOKS and
LEON KAUFMAN

MAILED
SEP 29 1995
PAT. & T.M. OFFICE
BOARD OF PATENT APPEALS
AND INTERFERENCES

Appeal No. 94-0700
Application 07/545,068[1]

HEARD: November 17, 1994

Before KRASS, CARDILLO and FLEMING, Administrative Patent Judges.

CARDILLO, Administrative Patent Judge.

DECISION ON APPEAL

This is a decision on the appeal taken under 35 U.S.C. § 134 from the examiner's rejection of claims 1-47, the only

[1] Application for patent filed June 29, 1990.

claims in this application. The amendment after final rejection has been indicated as approved for entry.[2]

The invention is directed to various aspects of improving magnetic resonance imaging methods and apparatus. The nature of the claimed subject matter is clear from a consideration of the various claims under appeal, a copy of which is attached as an appendix to this decision as it appears in the appendix attached to appellants' main brief.

The references of record relied upon by the examiner are:

Asahikawa Medical College (Asahikawa) (UK Patent Application)	2,128,745	May 2, 1984
Sepponen (UK Patent Application)	2,210,982	June 21, 1989

Claims 1-47 stand rejected under 35 U.S.C. § 103. As evidence of obviousness, the examiner offers Sepponen and Asahikawa.

Rather than repeat the arguments of appellants or the examiner, we make reference to the briefs and the answer for the details thereof.

OPINION

After a careful review of the record before us, we find that we will sustain the rejection of claims 1-5, 8, 10-15, 20-

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[2] Actual entry, thus, should be undertaken with dispatch upon return of the file.

29, 32-36 and 41-47 under § 103, but not that of claims 6, 7. 9, 16-19, 30, 31 and 37-40. However, we will apply a new ground of rejection as to claim 37 under the second paragraph of § 112 pursuant to the authority granted by 37 CFR § 1.196(b). Accordingly, we affirm-in-part.

Initially we note that appellants' statement that "[a]ll claims are argued below as being separately patentable" at page 8 of the main brief is inaccurate. Claims 1, 10, 14, 15, 20-25, 27-36, 41 and 43-46 are argued as to a time interval duration therein, see pages 10-13 of the main brief, while the specific interval of claim 3 is noted at page 10 of the main brief. On pages 13 and 14 of the main brief, claims 6, 7, 16, 17 and 38 are argued as to a common element as are claims 11, 32 and 42. At pages 14-15 of the main brief, appellants argue claims 9, 18, 19, 30, 39 an 40 in general as to one common feature and claims 19 and 40 in more detail. Similarly, claims 6, 8, 10, 11, 16, 17, 20, 32, 37, 38 and 40 are argued together as to one feature at page 15 of the main brief, while the details of claim 21 are separately argued at the bottom thereof. At page 16 of the main brief, an additional feature of claims 22-25 is noted, while a common "ability" of claims 5, 26, 29 and 47 is noted.

What is clear from all of this is that 37 CFR § 1.192(c)(6) requirements have not been met as to treating each claim individually. Instead, claims 2, 4, 12, and 13, all

dependent on claim 1, have not been argued alone or in terms of some common feature as to any other of the claims. Most of the other claims have been argued in groups as to a common or similar type of limitation. For instance, the argument offered as to claims 1 is no different from that offered as to claims 14, 15, 20, 27, 28, 33-36, 41 and 44-46. Accordingly, we shall treat claims 1, 2, 4, 12-15, 20, 27, 28, 33-36, 41 and 44-46 as one group of claims standing or falling with claim 1. In this regard, it is further clear that there is but one common argument offered as to claims 5, 26, 29 and 47 which will, accordingly, be treated as a second group of stand or fall claims. While there are two common arguments that apply to claims 22-25, these claims are not otherwise distinguished or argued separately from each other and will be treated as standing or falling as a group. We consider that claims 6, 7, 16, 17 and 38 have been essentially argued together and we will treat them as a group standing or falling together. Similarly, claims 9, 18, 19, 30 (and 31 dependent thereon), 39 and 40 have been argued in terms of a common feature not being taught by the applied art and will be treated as a group standing or falling together. Likewise, we will treat claims 8 and 10 as another stand or fall group and claims 11, 32, and 42 similarly. As to the remaining claims, claims 3 and 21 have indeed been separately argued and will be treated separately. We will treat claim 37 separately for the

reasons noted, infra, and claim 43 separately because we do not view it as properly argued as to any limitation therein at page 15 of the main brief.

Turning to the subject claim 1, we note that appellants first challenge the rejection applied with Sepponen as the primary reference because Sepponen is silent as to how long the augmenting field Bp is applied. From this silence as to some expressly stated duration, appellants conclude that they may assume that what they have disclosed to be the norm as to relaxation time can be read into the much broader statement of Sepponen "that nuclear magnetization is allowed to form (to relax) for at least part of the duration of an operating cycle in the resultant field of magnetic fields Bo and Bp" (page 6, lines 16-19).

We disagree that the lack of disclosure as to the duration of field overlap in terms of relaxation time can be read as a duration several times as long as one relaxation period simply because Bo and Bp are applied together for periods 1 and 1' of unknown duration, as the paragraph bridging pages 5 and 6 of the reply brief appears to suggest. Thus, we see no reasonable basis in Sepponen that would justify appellants' attempted importation of their assessment of a relatively long duration as to the application of Bo and Bp in terms of being tantamount to several relaxation periods. More importantly,

Sepponen is not relied upon to teach specific lengths of time to apply the fields or the effects thereof, Asahikawa is.

With respect to Asahikawa, appellants attempt to deny the clear teaching of the reference based upon their assessment of translation errors and the meaning of the examiner's relied upon phrase (at page 5, lines 45-48) being unfathomable. While the translation is far from ideal, the message carried would still be clear to the artisan in terms of an advantage as to a duration shorter than a spin-lattice relaxation time producing a "high response." If appellants had evidence to offer that demonstrated there was, in fact, a translation error or that there could be no correspondence between a "high response" and a shortening of the application of the polarizing field to less than the spin-axis relaxation time, it should have been presented. Argument cannot take the place of evidence not in the record. See In re Pearson, 494 F.2d 1399 181 USPQ 641 (CCPA 1974).

Absent evidence of either a translation error or that the "high response" is not dependent on the noted "fraction of the spin-lattice relaxation time" and heating effects noted at page 5 of the answer, we cannot say that the examiner's rationale is faulty or that the reference does not say what it clearly states. Moreover, we see nothing intrinsically wrong with the examiner's observations as to lines 9-20 of page 5 of the answer

except for the inadvertent use of the name Sepponen instead of Asahikawa at line 14.[3]

Thus, we agree with the thrust of the examiner's position that Asahikawa appears to be disclosing two possible extremes in operating conditions. Clearly, exposure to the combined fields for less time results in the reduced heating noted at page 5 of the answer as to page 2, lines 22-28 of Asahikawa. Col. 2, lines 1-3 of the abstract on the cover sheet of Asahikawa further teach that shorter duration pulses for Hm also reduce the need to stabilize the magnetic field. Of course, these benefits come at the price of a less than an optimum signal to noise ratio which would result from the fields Hm and Ho being applied for much longer periods of time.

However, Appellants' emphasis on statements relating to this other desirable characteristic in terms of an improved signal to noise ratio (and the corresponding need for the fields to both be present longer than the noted spin-axis relaxation time, or several times as long as that time), do not convince us that the statement that the examiner relies upon is erroneous or negated by this other expressed preference. All that a reference fairly teaches must be considered where reference teachings are

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[3] The error apparently misled appellants into thinking that Sepponen was actually intended notwithstanding the reference to page 2, lines 22-28 and the previous discussion of Asahikawa.

not limited to what has merely been presented to be but one preferred embodiment. In re Lamberti, 545 F.2d 747, 192 USPQ 278 (CCPA 1976) and In re Bode, 550 F.2d 656, 193 USPQ 12 (CCPA 1977).

Accordingly, we find that the language the examiner points to in Asahikawa does, in fact, reasonably suggest the use of a switched polarizing magnetic field for a duration that is less than the spin-lattice relaxation period as claim 1 sets forth. Since appellants, thus, have demonstrated no error to us as to the examiner's § 103 rejection of claim 1, we will sustain it. Since no significantly different arguments have been presented as to claims 2, 4, 12-15, 20, 27, 28, 33-36, 41 and 44-46, as we noted above, these claims will fall with claim 1.

The argument offered as to claim 3 is simply to note that it sets forth a range of values as to the duration of concern being between 0.3 times the spin-lattice relaxation constant and 0.6 times this constant. Noticeably lacking is something critical or unexpected as to this range that would render it patentable notwithstanding that it clearly encompasses values suggested by the fractional teaching of Asahikawa. Absent such a demonstrated criticality or unexpected result, the mere recitation of a range that falls within the range taught by the reference does not demonstrate patentability. Note In re

Wertheim, 541 F.2d 527, 191 USPQ 90 (CCPA 1976). Accordingly, we also sustain the § 103 rejection of claim 3.

Turning to the § 103 rejection of claim 5, we find that there is an "ability" to modify any of the variables listed in both of the applied references and an actual teaching of modifying the magnitude of the applied polarizing field by Asahikawa at page 10, lines 59-65 and, in the mapping context of Sepponen, at page 7, line 22 - page 8 line 7. While neither reference is particularly concerned with appellants' purpose in varying the magnitude of the field, the en banc decision of In re Dillon, 919 F.2d 688, 16 USPQ2d 1897 (Fed. Cir. 1990) makes it clear that reference teachings can be properly combined relative to demonstrating a prima facie case of obviousness even if the rationale used is not directed to appellants' specific purpose. As a consequence, we will sustain the § 103 rejection of claim 5. As noted above, no significantly different arguments have been advanced as to claims 26, 29 and 47, thus, we will also sustain their rejection under § 103 for the reasons we noted as to claim 5.

We reach the opposite conclusion as to claim 6, however. Claim 6 requires more than just opposing fields, it also requires that the application of the further switched polarizing field of step (a) of claim 1 must occur while step (b) of claim 1 is being performed. The examiner points to Sepponen's

Fig. 4 as somehow teaching this subject matter. However, we find ourselves in agreement with appellants' assessment that no such teaching appears here or elsewhere in the applied references in the paragraph bridging pages 10 and 11 of the reply brief. Consequently, we reverse the rejection of claim 6 and, as a result, also that of claims 7, 16, 17 and 38, as noted above.

As we also agree with appellants' assessment as to claims 9, 18, 19, 30, 31 (dependent on 30), 39 and 40 in terms of there being no reasonable reference suggestions existing as to the subject matter thereof as to fields being applied outside the image volume. Moreover, we note that the examiner has failed to come forth with any contradicting rationale or to point to something in either of the applied references teaching or reasonably suggesting the subject matter argued. Therefore, we will also reverse the § 103 rejection of these claim.

We do not agree with appellants as to claims 8 and 10, however. Appellants denied any teaching by Sepponen as to producing an opposite sense field in the main brief (page 15). The reply brief, on the other hand, admits the contrary at the bottom of page 11, although it fails to mention claims 8 and 10 in this context. In any event, we agree with the examiner that Sepponen does teach an opposing switched field, the only reason offered in the main brief as to finding error in this rejection

of these claims. Accordingly, we will sustain the § 103 rejection of claims 8 and 10.

Claims 11, 32 and 42 also contain an argued opposite switched field limitation. In addition, they are said to deal with suppression of certain nuclei in imaging because of the recited opposite field application as noted at page 12 of the reply brief and page 13 of the main brief. However, as we have noted above relative to Dillon, appellants' purpose in applying the switched field in an opposite sense does not control the determination of obviousness. Since these different purposes are all that is argued to define over the teachings of the applied reference, we will also sustain this § 103 rejection of claims 11, 32 and 42.

Appellant's challenge to the rejection of claim 21 is similar to that offered as to claims 11, 32 and 42. Again, we note that Sepponen applies the opposite field as claimed where the mere argument of a different purpose is again not convincing as to patentability, as set forth above. Therefore, we will also sustain this § 103 rejection of claim 21.

The arguments as to claims 22-25 involve an allegation as to a switched field combining with another field to form additive or subtractive effects. However, claim 22 recites a shaped image volume and no addition or subtraction as between the polarizing static field and the switched further polarizing

field. Since, in effect, no arguments specifically related to claim 22 subject matter have been presented to demonstrate the patentability thereof in the manner required by 37 CFR § 1.192(c)(6)(iv), we will sustain the rejection of claim 22. As we noted above, claims 23-25 will be treated as falling with claim 22.

We can also find no treatment of claim 43 subject matter at page 15, or anywhere else in the main brief. The page 15 argument of the main brief is directed to a switched field applied in an opposite sense to the static field, subject matter not in this claim. Once again, in the absence of any appropriate 37 CFR § 1.192(c)(6)(iv) argument as to the subject matter of claim 43, we will sustain the § 103 rejection thereof.

Lastly, we note that it is clear that claim 37 does not contain the subject matter noted at the top of page 14 of the main brief. However, it is further clear that some form of error in amending this claim has occurred because it has been amended to have identical means (a) and (b) which means (c) is said to repetitively operate. Since a rejection as to § 103 cannot be based upon conjecture as to what a claim means, see In re Steele, 305 F.2d 859, 134 USPQ 292 (CCPA 1962), we will reverse the § 103 rejection of this claim and add the appropriate second paragraph of § 112 rejection as a new ground of rejection.

NEW GROUND OF REJECTION
(37 CFR § 1.196(b))

Claim 37 is rejected under the second paragraph of 35 U.S.C. § 112 as being indefinite.

Claim 37 contains the clearly erroneous repetition of the means (a) and (b) noted above. As we must indulge in conjecture as to the intended difference between these two means, we find the claim to be indefinite.

Since we have sustained the rejection of claims 1-5, 8, 10-15, 20-29, 32-36 and 41-47 while reversing the rejection of claims 6, 7, 9, 16-19, 30, 31 and 37-40 and newly rejecting claim 37, the decision of the examiner is affirmed-in-part.

Any request for reconsideration or modification of this decision by the Board of Patent Appeals and Interferences based upon the same record must be filed within one month from the date hereof (37 CFR 1.197).

With respect to the new rejection under 37 CFR 1.196(b), should appellants elect the alternate option under that rule to prosecute further before the Primary Examiner by way of amendment or showing of facts, or both, not previously of record, a shortened statutory period for making such response is hereby set to expire two months from the date of this decision. In the event appellants elect this alternate option, in order to

preserve the right to seek review under 35 U.S.C. 141 or 145 with respect to the affirmed rejection, the effective date of the affirmance is deferred until conclusion of the prosecution before the examiner unless, as a mere incident to the limited prosecution, the affirmed rejection is overcome.

If the appellants elect prosecution before the examiner and this does not result in allowance of the application, abandonment or a second appeal, this case should be returned to us for final action on the affirmed rejection, including any timely request for reconsideration thereof.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 CFR 1.136(a).

AFFIRMED-IN-PART, 37 CFR 1.196(b)

ERROL A. KRASS)
Administrative Patent Judge)
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RAYMOND F. CARDILLO, Jr.) BOARD OF PATENT
Administrative Patent Judge) APPEALS AND
) INTERFERENCES
)
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MICHAEL R. FLEMING)
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Appeal No. 94-0700
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APPENDIX I

CLAIMS ON APPEAL

1. A magnetic resonance imaging method performed with a constant substantially homogeneous, static polarizing magnetic field B_o generator and a plurality of pulsed gradient magnetic field G_x, G_y, G_z generators applied to nuclei to be imaged, said method comprising the steps of:

(a) applying a switched further polarizing magnetic field to said nuclei during a time interval Δt_1, which is less than the spin-lattice relaxation constant T1 NMR parameter of said nuclei; and

(b) performing an NMR pulse sequence including application of at least one RF NMR nutation pulse and a responsive RF NMR signal reception time window for acquiring MRI data.

2. A magnetic resonance imaging method as in claim 1 further comprising:

(c) repeating steps (a) and (b) during each of plural successive repetition intervals TR to acquire a set of related MRI data wherein step (a) is completed prior to step (b).

3. A magnetic resonance imaging method as in claim 2 wherein TR is less than 3 T1 and Δt_1 is in the range of 0.3 T1 to 0.6 T1.

4. A magnetic resonance imaging method as in claim 3 wherein said further polarizing magnetic field is oriented in the same direction as said static polarizing magnetic field B_o.

5. A magnetic resonance imaging method as in claim 1 wherein MRI image contrast is enhanced for a given MRI data set by controllably changing at least one of the following parameters: the magnitude of said further polarizing magnetic field, the time interval Δt_1 and/or a time interval Δt_2 controlling the relative timing of steps (a) and (b).

6. A magnetic resonance imaging method as in claim 1 wherein step (a) occurs during occurrence of step (b) and wherein said further polarizing magnetic field opposes said static magnetic field B_o.

7. A magnetic resonance imaging method as in claim 6 wherein step (b) includes an NMR spectroscopic imaging pulse sequence having at least one transmitted RF NMR pulse and wherein step (a) occurs only during transmission of said RF NMR pulse(s).

8. A magnetic resonance imaging method as in claim 1 wherein step (a) is completed prior to step (b) and wherein said further polarizing magnetic field opposes said static magnetic field B_o.

9. A magnetic resonance imaging method as in claim 1 wherein said further polarizing magnetic field is oriented in the same direction as said static magnetic field B_o and is applied during step (a) to moving nuclei outside an MRI image volume prior to step (b) so as to enhance their magnetization upon subsequent entry into the image volume.

10. A magnetic resonance imaging method as in claim 1 or 9 wherein a magnetic field is applied, during step (a), inside the image volume and in opposition to said static polarizing magnetic field B_o.

11. A magnetic resonance imaging method performed with a constant substantially homogeneous, static magnetic field B_o generator and a plurality of pulsed gradient magnetic field G_x, G_y, G_z generators applied to nuclei to be imaged said method comprising the steps of:

(a) applying a switched further polarizing magnetic field to said nuclei during a time interval Δt_1; and

(b) performing an NMR pulse sequence including application of at least one RF NMR mutation pulse and a responsive RF NMR signal reception time window for acquiring MRI data;

wherein step (a) is completed prior to performance of step (b),

wherein said further polarizing magnetic field is substantially equal and opposite said static polarizing field B_o in at least a portion of an imaged volume, and

wherein Δt_1 is approximately equal to or greater than the spin-lattice relaxation constant T1 NMR parameter of nuclei to be suppressed from imaging.

12. A magnetic resonance imaging method as in claim 1 including shaping of said further polarizing magnetic field with respect to an image volume so as to enhance imaging of nuclei from selected portions thereof while relatively suppressing imaging of nuclei from other selected portions of the image volume.

13. A magnetic resonance imaging method as in claim 1 wherein said NMR sequence comprises a stimulated echo sequence having an initial RF NMR nutation pulse and step (a) is performed after said initial RF NMR nutation pulse.

14. A magnetic resonance imaging method performed with a constant, substantially homogeneous, static polarizing magnetic field B_o generator and a plurality of pulsed gradient magnetic field G_x, G_y, G_x generators applied to nuclei to be imaged, said method comprising the steps of:

(a) applying a switched further polarizing magnetic field to said nuclei during a time interval Δt, which is substantially less than three times the spin-lattice relaxation constant T1 NMR parameter of said nuclei; and

(b) performing an entire MRI sequence after step (a) during which MRI sequence said further polarizing magnetic field is switched off.

15. A magnetic resonance imaging method as in claim 1 or 14 further comprising:

(c) prior to step (a), applying at least one RF NMR nutation pulse to said nuclei.

16. A magnetic resonance imaging method performed with a constant, substantially homogeneous, static polarizing magnetic field B_o generator and a plurality of pulsed gradient magnetic field G_x, G_y, G_z generators applied to nuclei to be imaged, said method comprising the steps of:

(a) applying a switched further polarizing magnetic field to said nuclei which opposes said static magnetic field B_o;

(b) during Step (a) performing an NMR pulse sequence including application of at least one RF NMR nutation pulse and a responsive RF NMR signal reception time for acquiring MRI data; and

(c) repeating steps (a) and (b) during plural successive repetition intervals TR which include a period when said further polarizing magnetic field is not applied.

17. A magnetic resonance spectroscopic imaging method performed with a constant, substantially homogeneous, polarizing static magnetic field B_o generator and a plurality of pulsed gradient magnetic field G_x, G_y, G_z generators applied to nuclei to be imaged, said method comprising the steps of:

(a) performing an NMR spectroscopic pulse sequence including application of at least one RF NMR nutation pulse and a responsive RF NMR signal reception time for acquiring MRSI data during each of plural successive repetition intervals TR; and

(b) during application of said RF NMR nutation pulse(s) applying a switched further polarizing magnetic field to said

nuclei which opposes said static magnetic field B_o thereby reducing required RF transmission power and frequency.

18. A magnetic resonance imaging method performed with a constant, substantially homogeneous, static polarizing magnetic field B_o generator and a plurality of pulsed gradient magnetic field G_x, G_y, G_z generators applied to nuclei to be imaged within an image volume, said method comprising the steps of:

(a) applying a switched further polarizing magnetic field to nuclei outside said image volume which is in the same sense as said static polarizing magnetic field B_o;

(b) after step (a), performing an NMR pulse sequence including application of at least one RF NMR nutation pulse and a responsive RF NMR signal reception time for acquiring MRI data; and

(c) repeating steps (a) and (b) during plural successive repetition intervals TR to acquire a set of related MRI data.

19. A magnetic resonance imaging method as in claim 18 further comprising, during step (a), also applying another switched polarizing magnetic field to nuclei inside said image volume in an opposite sense to said static polarizing magnetic field B_o.

20. A magnetic resonance imaging method performed with a constant, substantially homogeneous, static polarizing magnetic field B_o generator and a plurality of pulsed gradient magnetic field G_x, G_y, G_z generators applied to nuclei to be imaged within an image volume, said method comprising the steps of:

(a) applying a switched further polarizing magnetic field selectively to nuclei inside said image volume which is in an opposite sense to said static polarizing magnetic field B_o for a time interval Δt_1 which is less than the spin-lattice relaxation constant T1 NMR parameter of the nuclei to be imaged;

(b) after step (a), performing an NMR pulse sequence including application of at least one RF NMR nutation pulse and a responsive RF NMR signal reception time for acquiring MRI data; and

(c) repeating steps (a) and (b) during plural successive repetition intervals TR to acquire a set of related MRI data.

21. A magnetic resonance imaging method performed with a constant, substantially homogeneous, static magnetic field B_o generator applied to nuclei to be imaged within an image volume, said method comprising the steps of:

(a) applying a pulse of further magnetic field to nuclei inside said image volume which is in an opposite sense and approximately equal in magnitude to said static field B_o, said pulse having a duration approximately equal to or greater than the spin-lattice relaxation constant T1 NMR parameter of nuclei to be suppressed from imaging;

(b) performing an NMR pulse sequence including application of RF NMR nutation pulses(s), magnetic gradient pulses and a responsive RF NMR signal reception time for acquiring MRI data; and

(c) repeating steps (a) and (b) during plural successive repetition intervals TR to acquire a set of related MRI data.

22. A magnetic resonance imaging method performed with a constant, substantially homogeneous, polarizing static magnetic field B_o and a plurality of pulsed gradient magnetic field G_x, G_y, G_z generators applied to nuclei to be imaged within an image volume, said method comprising the steps of:

(a) applying a switched further polarizing magnetic field selectively to nuclei inside said image volume which is shaped so as to preferentially affect the net magnetic field in a predetermined portion of the image volume for a time interval

Δt_1 which is less than the spin-lattice relaxation constant T1 NMR parameter of the nuclei to be imaged;

(b) after step (a), performing an NMR pulse sequence including application of at least one RF NMR nutation pulse and a responsive RF NMR signal reception time for acquiring MRI data, and

(c) repeating steps (a) and (b) during plural successive repetition intervals TR to acquire a set of related MRI data.

23. A magnetic resonance imaging method as in claim 22 wherein said further polarizing magnetic field is oriented in the same direction as said static polarizing field B_o in a selected portion of the image volume.

24. A magnetic resonance imaging method as in claim 23 wherein said further polarizing magnetic field opposes said static polarizing field B_o in a selected second portion of the image volume.

25. A magnetic resonance imaging method as in claim 22 wherein said further polarizing magnetic field opposes said static polarizing field B_o in a selected portion of the image volume.

26. A magnetic resonance imaging method performed with a constant, substantially homogeneous, static polarizing magnetic field B_o generator and a plurality of pulsed gradient magnetic field G_x, G_y, G_z generators applied to nuclei to be imaged, said method comprising the steps of:

(a) applying a switched further polarizing magnetic field to said nuclei of controllable magnitude, duration and time of occurrence;

(b) performing an NMR pulse sequencer including application of at least one RF NMR nutation pulse and a responsive RF NMR signal reception time for acquiring MRI data;

(c) repeating steps (a) and (b) during plural successive repetition intervals TR to acquire a set of related MRI data; and

(d) controlling at least one of said magnitude, duration and time of occurrence parameters to increase image contrast in an MRI image created using said MRI data.

27. A magnetic resonance imaging apparatus having a constant substantially homogeneous, static polarizing magnetic field B_o generator and a plurality of pulsed gradient magnetic field G_x, G_y, G_z generators applied to nuclei to be imaged, said apparatus comprising:

(a) means for applying a switched further polarizing magnetic field to said nuclei during a time interval Δt_1, which is less than the spin-lattice relaxation constant T1 NMR parameter of said nuclei; and

(b) means for performing an NMR pulse sequence including application of at least one RF NMR nutation pulse and a responsive RF NMR signal reception time window for acquiring MRI data.

28. A magnetic resonance imaging apparatus as in claim 27 further comprising:

(c) means for repetitively operating means (a) and (b) during plural successive repetition intervals TR to acquire a set of related MRI data,

29. A magnetic resonance imaging apparatus as in claim 27 including means for enhancing MRI image contrast for a given MRI data set by controllably changing at least one of the following parameters: the magnitude of said further polarizing magnetic field, the time interval Δt_1 and/or a time interval Δt_2 controlling the relative timing steps (a) and (b).

30. A magnetic resonance imaging apparatus as in claim 27 wherein said further polarizing magnetic field is oriented in the same direction as said static polarizing magnetic field B_o

and is applied to moving nuclei outside an MRI image volume so as to enhance their magnetization upon subsequent entry into the image volume.

31. A magnetic resonance imaging apparatus as in claim 30 wherein another polarizing magnetic field also is applied, inside the image volume and in opposition to said static polarizing magnetic field B_o.

32. A magnetic resonance imaging apparatus having a constant substantially homogeneous, static magnetic field B_o generator and a plurality of pulsed gradient magnetic field G_x, G_y, G_z generators applied to nuclei to be imaged, said apparatus comprising:

(a) means for applying a switched further polarizing magnetic field to said nuclei during a time interval Δt_1 and

(b) means for performing an NMR pulse sequence including application of at least one RF NMR nutation pulse and a responsive RF NMR signal reception time window for acquiring MRI data;

wherein said further polarizing magnetic field is substantially equal and opposite said static field B_o in at least a portion of an imaged volume, and

wherein Δt_1 is approximately equal to or greater than the spin-lattice relaxation constant T1 NMR parameter of nuclei to be suppressed from imaging.

33. A magnetic resonance imaging apparatus as in claim 27 wherein said means for applying a switched further polarizing magnetic field includes means for generating a further polarizing magnetic field which is shaped with respect to an image volume so as to enhance imaging of nuclei from selected portions thereof while relatively suppressing imaging of nuclei from other selected portions of the image volume.

34. A magnetic resonance imaging apparatus as in claim 27 wherein said NMR sequence comprises a stimulated echo sequence having an initial RF NMR nutation pulse and means (a) operates in conjunction with means (b) so as to apply said further polarizing magnetic field after said initial RF NMR nutation pulse.

35. A magnetic resonance imaging apparatus used with a constant, substantially homogeneous, static polarizing magnetic field B_o generator and a plurality of pulsed gradient magnetic field G_x, G_y, G_z generators applied to nuclei to be imaged, said apparatus comprising:

(a) means for applying a switched further polarizing magnetic field to said nuclei during a time interval Δt, which is substantially less than three times the spin-lattice relaxation constant T1 NMR parameter of said nuclei; and

(b) means for performing an entire MRI sequence after step (a) during which MRI sequence said further polarizing magnetic field is switched off.

36. A magnetic resonance imaging apparatus as in claim 35 further comprising:

(a) means for applying at least one RF NMR nutation pulse to said nuclei prior to the application of said switched further polarizing magnetic field.

37. A magnetic resonance imaging apparatus having a constant, substantially homogeneous, static polarizing magnetic field B_o generator and a plurality of pulsed gradient magnetic field G_x, G_y, G_z generators applied to nuclei to be imaged, said apparatus comprising:

(a) means for applying a switched further polarizing magnetic field to said nuclei which opposes said static polarizing magnetic field B_o;

(b) means for applying a switched further polarizing magnetic field to said nuclei which opposes said static polarizing magnetic field B_o;

(c) means for repetitively operating means (a) and (b) during plural successive repetition intervals TR which includes a sample preparation period when said further magnetic field is not applied.

38. A magnetic resonance spectroscopic imaging apparatus having a constant, substantially homogeneous, static polarizing magnetic field, B_o generator and a plurality of pulsed gradient magnetic field G_x, G_y, G_z generators applied to nuclei to be imaged, said apparatus comprising:

(a) means for performing an NMR spectroscopic pulse sequence including application of at least one RF NMR nutation pulse and a responsive RF NMR signal reception time for acquiring MRSI data during each of plural successive repetition intervals TR; and

(b) means for, during application of said RF NMR nutation pulse(s), applying a switched further polarizing magnetic field to said nuclei which opposes said static polarizing magnetic field B_o thereby reducing required RF transmission power and frequency.

39. A magnetic resonance imaging apparatus having a constant, substantially homogeneous, static polarizing magnetic field to B_o generator and a plurality of pulsed gradient magnetic field G_x, G_y, G_z generators applied to nuclei to be imaged within an image volume, said apparatus comprising:

(a) means for selectively applying a switched further polarizing magnetic field to nuclei outside said image volume which is in the same sense as said static polarizing magnetic field B_o;

(b) means for performing an NMR pulse sequence including application of at least one RF NMR nutation pulse and a responsive RF NMR signal reception time for acquiring MRI data; and

(c) means for repetitively operating means (a) and (b) during plural successive repetition intervals TR to acquire a set of related MRI data.

40. A magnetic resonance imaging apparatus as in claim 39 further comprising, also applying another switched polarizing magnetic field to nuclei inside said image volume in an opposite sense to said static polarizing magnetic field B_o.

41. A magnetic resonance imaging apparatus including a constant, substantially homogeneous, static polarizing magnetic field B_o generator and a plurality of pulsed gradient magnetic field G_x, G_y, G_z generators applied to nuclei to be imaged within an image volume, said apparatus comprising:

(a) means for applying a switched further polarizing magnetic field to nuclei inside said image volume which is in an opposite sense to said static polarizing magnetic field B_o for a time interval Δt, which is less than the spin-lattice relaxation constant T1 NMR parameter of the nuclei to be imaged;

(b) means for performing an NMR pulse sequence including application of at least one RF NMR nutation pulse and a responsive RF NMR signal reception time for acquiring MRI data; and

(c) means for repetitively operating means (a) and (b) during plural successive repetition intervals TR to acquire a set of related MRI data.

42. A magnetic resonance imaging apparatus including a constant, substantially homogeneous, static polarizing magnetic field B_o generator and a plurality of pulsed gradient magnetic field G_x, G_y, G_z generators applied to nuclei to be imaged within an image volume, said apparatus comprising:

(a) means for applying a pulse of further polarizing magnetic field to nuclei inside said image volume which is in an opposite sense and approximately equal in magnitude to said static polarizing filed B_o, said pulse having a duration approximately equal to or greater than the spin-lattice relaxation constant T1 NMR parameter of nuclei to be suppressed from imaging;

(b) means for performing an NMR pulse sequence including application of at least one RF NMR nutation pulse and a responsive RF NMR signal reception time for acquiring MRI data; and

(c) means for repetitively operating means (a) and (b) during plural successive repetition intervals TR to acquire a set of related MRI data.

43. A magnetic resonance imaging apparatus including a constant, substantially homogeneous, static polarizing magnetic field B_o generator and a plurality of pulsed gradient magnetic field G_x, G_y, G_z generators applied to nuclei to be imaged within an image volume, said apparatus comprising:

(a) means for applying a switched further polarizing magnetic field to nuclei inside said image volume which is shaped so as to preferentially affect the net magnetic field in

a predetermined portion of the image volume for a time interval Δt_1 which is less than the spin-lattice relaxation constant T1 NMR parameter of the nuclei to be imaged;

(b) means for performing an NMR pulse sequence including application of at least one RF NMR nutation pulse and a responsive RF NMR signal reception time for acquiring MRI data, and

(c) means for repetitively operating means (a) and (b) during plural successive repetition intervals TR to acquire a set of related MRI data.

44. A magnetic resonance imaging apparatus as in claim 43 wherein said further polarizing magnetic field is oriented in the same direction as said static polarizing field B_o in a selected portion of the image volume.

45. A magnetic resonance imaging apparatus as in claim 44 wherein said further polarizing magnetic field opposes said static polarizing field B_o in a selected second portion of the image volume.

46. A magnetic resonance imaging apparatus as in claim 43 wherein said further polarizing magnetic field opposes said

static polarizing field B_o in a selected portion of the image volume.

47. A magnetic resonance imaging apparatus including a constant, substantially homogeneous, static polarizing magnetic field B_o generator and a plurality of pulsed gradient magnetic field G_x, G_y, G_z generators applied to nuclei to be imaged, said apparatus comprising:

(a) means for applying a switched further polarizing magnetic field to said nuclei of controllable magnitude, duration and time of occurrence;

(b) means for performing an NMR pulse sequence including application of at least one RF NMR nutation pulse and a responsive RF NMR signal reception time for acquiring MRI data;

(c) means for repetitively operating means (a) and (b) during plural successive repetition intervals TR to acquire a set of related MRI data; and

(d) means for controlling at least one of said magnitude, duration and time of occurrence parameters to increase image contrast in an MRI image created using said MRI data.